Introduction to Experimental Economics

Syngjoo Choi

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TA: Andrea Locatelli (loc.andrea@gmail.com). He will deliver tutorial classes four times this term for each tutorial group.

Contact Info. and Course Webpage

- Office: Room 111, Drayton House
- The course materials, including lecture notes, will be available at http://www.homepages.ucl.ac.uk/~uctpsc0/Teaching/ECON3020.html/
- Office hours: by appointment.

Two-hour exam with three compulsory questions and a choice of one out of three. Sample exams in previous years are available in the teaching website.
Main Textbook


Other readings


Lecture notes will be available in the website.
Course Outline

- Week 1 - Introduction to experimental economics
  - Overview and history
  - Methodology
  - Market experiments

- Week 2 - Individual preferences: uncertainty and time
  - Theories on individual decision making under uncertainty (risk and ambiguity) over time
  - Anomalies established by experiments and further issues on experiments

- Week 3 - Introduction to experiments on game theory
  - Some simple games and their experiments
  - Experimental regularity and behavioral game theory
• Week 4 - Bargaining and social preferences
  • Selfish preference vs. social preferences: ultimatum bargaining and dictator game
  • Reciprocity: trust games

• Week 5 - Coordination and Public Goods
  • Games with multiple equilibria
  • Equilibrium selection
  • Public good games

• Weeks 6 - More experiments on game theory
  • Mixed strategies
  • Strategic sophistication
  • Communication
- Week 7 - Auctions
  - Private value vs. common value auctions
  - Other issues
- Week 8 - Information and Learning
  - Bayes’ rule
  - Learning from others’ decisions
- Week 9 - Field Experiments
- Week 10 - Students’ presentations
There will be four tutorial classes on Tuesdays (Jan. 26 / Feb. 9 / Mar. 2 / Mar. 16).

In the first three tutorials, the class teacher will go over problem sets that will be handed out a week before. Students will need to work out each problem set and submit their homework to the class teacher before tutorials.

In the last tutorial class and lecture, students will make group presentations for their own design of experiments.
For the group presentation, you will need to form groups of four people. Group formation will need to be reported to the TA by Feb. 12 (Friday).

Each group will make 15~20 minute presentation for its own design of experiment. The presentation will consist largely of

- research questions / hypotheses;
- related theories;
- related literature;
- experimental design

Each group is suppose to write an essay of 5 ~10 pages about their own experimental design and submit it to the TA by March 15 (Monday).

Submitted problem sets and essays will be used by the class teacher to write your class reports at the end of the term.
The interaction between theory and empirical work is the *engine of progress* in most academic disciplines.

Data for empirical work can be drawn from several types of sources.

One distinction can be drawn between *experimental* data and *observational* data.

- Experimental data are deliberately created for scientific or other purposes under *controlled* conditions;
- Happenstance / observational data are a by-product of ongoing *uncontrolled* processes;

Another distinction can be drawn between laboratory data and field data.

- Laboratory data are gathered in an artificial, lab environment designed for scientific or other purposes;
- Field data are gathered in a naturally occurring environment.
Economics was traditionally taken to be a non-experimental science. For instance, Milton Friedman (1953) says:

_Unfortunately, we can seldom test particular predictions in the social sciences by experiments explicitly designed to eliminate what are judged to be the most important disturbing influences. Generally, we must rely on evidence cast up by the “experiments” that happen to occur._

It implies that the methods of economics, like those of astronomy, are an adaptation to the practical impossibility of controlled experiments.
But, from the 1980s onwards, there has been an explosive growth in the use of experimental methods in economics.

In terms of most obvious signals, these methods are now accepted as part of the discipline.

In 2002, Daniel Kahneman and Vernon Smith were awarded the Nobel memorial prize in recognition of their work as pioneers of experimental economics.

However, experimental methods remain controversial in economics.
Experimental economics is not a unified, standardized research program.

Indeed, the two Nobel memorial prize winners represent two very different lines of research:

- Smith is an economist who has developed novel experimental techniques to investigate traditional economic questions about markets;
- Kahneman is a psychologist who has used the well-established experimental methods of his discipline to challenge economists’ conventional assumptions about the rationality of economic agents.
There are still ongoing disputes about, for example,

- what economics should learn from experimental results;
- whether (or in what sense) economic theory can be tested in laboratory experiments;
- how far traditional theory needs to be adapted in the light of experimental results.

This course intends to help you judge, for yourselves, the status of experimental methods by learning some key experiments in economics.
Some principles of economics experiments

- Controls and inducing values;
- Randomization and causality;
- Incentives;
- Validity;
- No deception.
Controls

- Control is the essence of experimental methodology.
- An experiment takes place in a controlled economic environment consisting of individual agents and an institution through which the agents interact.
  - Agents are defined by economic characteristics such as preferences, resource endowments, and information.
  - An institution specifies the choices available to agents and the outcomes resulting from each possible combination of agents’ choices.
- Experimental control over the institution is conceptually straightforward.
- Individual subjects usually bring their own home-grown characteristics in the lab. Sometimes you may want to measure such characteristics.
- Other times you may want to control them and induce some prescribed characteristics to examine some theories.
Vernon Smith (1976, 1982) suggests the induced-value theory that proper use of reward medium allows an experimenter to induce pre-specified characteristics and make subjects’ innate characteristics become largely irrelevant.

- **monotonicity:** more reward is better;
- **salience:** reward depends on actions chosen by subjects;
- **dominance:** reward medium dominantly determines changes in subjects’ utility. Other influences (such as demand effects and cares about other subjects’ rewards) are negligible.
To illustrate, suppose you want to induce some specific smooth preferences represented by $U(x, y)$.

Pick convenient objects such as colored slips of paper: $x = (\# \text{ of slips of red paper}); y = (\# \text{ of slips of blue paper})$, and explain to the subject that his payment will be $\Delta m = U(x, y)$.

Then the induced preferences are $W(x, y) = V(m_0 + U(x, y), z_0 + \Delta z)$, where $(m_0, z_0)$ is the subject’s unobservable initial endowment of money and everything else.
Two utility functions represent the same preferences if their marginal rates of substitution always coincide:

$$MRS^W = \frac{W_x}{W_y} = \frac{V_m U_x + V_z \Delta z_x}{V_m U_y + V_z \Delta z_y} = \frac{U_x}{U_y} = MRS^U$$

The experimenter can freely choose any relationship between intrinsically worthless objects and the reward medium.

As long as he can explain the relationship clearly to the subject (salience) and subjects are motivated by the reward medium (monotonicity) and not other influences (dominance), then the experimenter can control subjects’ innate characteristics to induce pre-specified characteristics.
Variables that are not directly controlled are typically controlled via randomization (random recruiting of subjects).

The causal effect of the treatment is the expected effect on the outcome of interest of the treatment as measured in an ideal randomized controlled experiment.

The role of random assignment can be considered in terms of a simple regression framework:

$$Y_i = \beta_0 + \beta_1 X_i + u_i,$$

where $X_i$ is the treatment level and $u_i$ contains all other factors determining the outcome $Y_i$. 
If $X_i$ is randomly assigned, then $X_i$ is distributed independently of $u_i$. Thus,

$$E(Y \mid X) = \beta_0 + \beta_1 X.$$ 

The causal effect on $Y$ of the treatment level $x$ is the difference in the conditional expectations:

$$E(Y \mid X = x) - E(Y \mid X = 0)$$

In the context of experiments, the causal effect is called the *treatment* effect.
Monetary incentives lie at the heart of controversies in experimental economics and, even more markedly, between it and other disciplines such as psychology.

The two most common types of payments from experimenters to subjects are flat-rate show-up fees and task-related payments.

- Show-up fees are rewards for participation;
- task-related payments depend on what happens during the experiment, such as choices made by subjects, resolution of gambles, and so on.
A conventional wisdom of experimental economics is that tasks should be *incentive compatible*.

Engineering incentive compatibility amounts to designing experiments so that subjects are motivated to give *truthful* responses to experimenter’s questions.

The mere presence of financial incentives, related to task performance, is clearly no guarantee of incentive compatibility.

For instance, suppose that subjects are endowed with a particular good and an experimenter asks “what is your willingness to accept for giving up this good?”

Now imagine a naive design in which subjects are paid an amount equivalent to the value they state. What do you expect?
Validity (or relevance)

- An experimental study is *internally valid* if the statistical inferences about causal effects through an experiment is valid for the population being studied.

- It is *externally valid* if the inferences and conclusions from an experiment can be generalized to other populations and settings.

- There are threats to internal validity:
  - failure to randomize;
  - failure to follow treatment protocol;
  - experimenter effects.

- There are threats to external validity:
  - nonrepresentative samples;
Other methodological considerations

- **Instructions** tell subjects what they need to know. It is scientifically very useful to have a clear instructional script that enables precise replication.

- Reading instructions out loud is a common practice to establish “public knowledge“ (this is especially important in experiments on game theory).

- In “within-subjects” design, a single subject is observed in different treatments. In a “between-subjects” design, different subjects are tested in different treatments. Within-subject designs are more statistically powerful than between-subject designs because they control for individual differences.
A rich literature in economics and psychology documents psychological aspects of decision making that may have strong effects on economic behavior. These are sometimes called *biases* or *anomalies*.

Most relevant anomalies and biases are such as loss aversion, status quo bias, endowment effects, etc.

Unless they are of direct interest, one should try hard to control such psychological biases in experiments.

An important design decision pertains to the amount and richness of context to provide. It is an accepted practice in economics experiments to strip away a lot of social context that is not an essential part of the economic theories being tested.
Assumptions of perfect competition

- The standard theory of competitive markets (based on supply and demand curves) relies on several assumptions:
  - economic agents (buyers and sellers) are rational and self-motivated (either utility / profit maximization);
  - a single homogeneous good is traded;
  - there are a large number of buyers and sellers;
  - economic agents behave as price-takers.

- All these assumptions can be questioned
  - In many instances people are bounded rational and have interdependent utility functions;
  - There are many markets with only a few firms;
  - In most markets there is no auctioneer but agents set prices.
It is often difficult to test the theory with a naturally occurring market dataset because

- one needs to make strong assumptions to identify demand/supply curves;
- it is difficult to guarantee if equilibrium is achieved at a specific time point in the market.

In a laboratory setting, one can control the schedules of demand and supply and trading institution. Earlier examples are Chamberlin (1948) and Smith (1962, 1964).
Questions

- Do these deviations from the assumptions constitute negligible frictions or do they seriously challenge the predictive power of the model?
- Are there “real” market institutions for which the competitive equilibrium is a good predictor of price and quantity outcomes?
- How do different market institutions affect efficiency and convergence to the competitive equilibrium?
What constitutes a market experiment?

- Two distinct elements are identified in defining a Market experiment: *environment* and *institution*.
- An *environment* is defined by a set of initial circumstances such as the number of buyers and sellers, their preferences and initial endowments, which is a primitive in an experiment.
- A *market institution* is a full specification of the rules of trade: the messages of market communication (bids/asks) and a trading procedure (double auction / posted-offer auction).
- Finally, there is the observed *behavior* of the participants in the experiments as a function of the environment and institution that constitute the controlled variables.
Chamberlin’s Experiment

One of the earliest experiments was done by Chamberlin (1948), where he created an experimental market by informing each buyer and seller of his reservation price for a single unit of an indivisible commodity.

- subjects were divided equally into two groups, buyers and sellers;
- to induce demand and supply curves, each seller (buyer) was given a card with a cost (value) written on it;
- buyers and sellers mix together and negotiate bilaterally or in small groups in a trading floor or “pit”.
- trading prices were written on the blackboard;

Chamberlin wanted to see whether this experimental market leads to the outcome of a competitive equilibrium.
An Example: induced values and costs

Table 2.1. A Market Example

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Values</th>
<th>Seller</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyer 1</td>
<td>$10</td>
<td>Seller 9</td>
<td>$2</td>
</tr>
<tr>
<td>Buyer 2</td>
<td>$10</td>
<td>Seller 10</td>
<td>$2</td>
</tr>
<tr>
<td>Buyer 3</td>
<td>$10</td>
<td>Seller 11</td>
<td>$2</td>
</tr>
<tr>
<td>Buyer 4</td>
<td>$10</td>
<td>Seller 12</td>
<td>$2</td>
</tr>
<tr>
<td>Buyer 5</td>
<td>$4</td>
<td>Seller 13</td>
<td>$8</td>
</tr>
<tr>
<td>Buyer 6</td>
<td>$4</td>
<td>Seller 14</td>
<td>$8</td>
</tr>
<tr>
<td>Buyer 7</td>
<td>$4</td>
<td>Seller 15</td>
<td>$8</td>
</tr>
<tr>
<td>Buyer 8</td>
<td>$4</td>
<td>Seller 16</td>
<td>$8</td>
</tr>
</tbody>
</table>
An equilibrium price can be anywhere between $4 and $8 and equilibrium quantity is 4 units. But there exist more feasible allocations.
Chamberlin’s Experiment: induced demand and supply
Chamberlin’s Findings

The graph illustrates the price changes over 20 transactions. It shows actual prices, moving equilibrium, perfectly competitive equilibrium, and average price. The graph reveals fluctuations in prices, with several peaks and troughs, indicating dynamic market behavior over the transactions.
Vernon Smith’s Experiment

- Vernon Smith (1962, 1964) introduced two changes from Chamberlin’s market experiment:
  - Instead of bilateral negotiation, he used a double (oral) auction;
  - Trading was repeated in successive market periods or trading days in order to have stationary replication.
Double Auction (DA)

- Each buyer $i$ is endowed with a maximum willingness to pay, $V_i$, and each seller $j$ is endowed with a reservation price, $U_j$.
- Each buyer sets a bid price for the unit of the good, $B_i$, each seller sets an ask price for the unit, $A_j$, and all could see the highest outstanding bid and the lowest outstanding ask.
- Buyers could raise the current best bid at any time, and sellers could undercut the current best ask at any time.
- A trade occurs when these processes meet, i.e., when a buyer accepts a seller’s ask ($p = A_j$) or when a seller accepts a buyer’s bid ($p = B_i$).
- If a trade occurs, a buyer’s payoff is $V_i - p$ and a seller’s payoff is $U_j - p$. If not, the payoff for each is zero.
- If a trade occurs, a matched pair of buyer and seller is out of the market. And the remaining buyers and sellers continue this process until the end of trading time.
### Table 2.3. A Price Negotiation Sequence

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Bid</th>
<th>Ask</th>
<th>Seller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyer 2</td>
<td>$3.00</td>
<td>$8.00</td>
<td>Seller 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$7.50</td>
<td>Seller 6</td>
</tr>
<tr>
<td>Buyer 1</td>
<td>$4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buyer 1</td>
<td>$4.50</td>
<td>$6.00</td>
<td>Seller 7</td>
</tr>
<tr>
<td>Buyer 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptor $6.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Classroom Experiment

- Go to http://veconlab.econ.virginia.edu/login.htm
- Session name is _____. And then register to participate in a classroom experiment.
Research Questions

- Do prices converge to a competitive equilibrium over time?
  - $\alpha = 100 \times \left( \frac{\sigma}{p_{CE}} \right)$, where $p_{CE}$ denotes the predicted equilibrium price and $\sigma$ denotes the standard deviation of prices around $p_{CE}$.
  - Does $\alpha$ decrease over time?

- Does the efficiency increase over time?
  - Efficiency can be defined by the ratio of the actual earnings of all participants with the maximum possible earnings.
Smith (1962)’s finding: symmetric supply and demand curves
Smith (1962)’s finding: structural changes in demand and supply
“I am still recovering from the shock of the experimental results. The outcome was unbelievably consistent with competitive price theory. ... But the result can’t be believed, I thought. It must be an accident, so I will take another class and do a new experiment with different supply and demand schedules.” (Smith 1991)
Flat Demand and Supply Curves: quick convergence
Steep Demand and Supply Curves: less quick convergence

TEST 3

$P_0 = 3.45, \; x_0 = 16$

$\alpha = 16.5, \; \alpha = 6.6, \; \alpha = 3.7, \; \alpha = 5.7$

PERIOD 1 | PERIOD 2 | PERIOD 3 | PERIOD 4

PRICE

QUANTITY

TRANSACTION NUMBER (BY PERIOD)
Excess Demand

Price Series for Four Trading Periods
Under weaker conditions than had traditionally thought to be necessary, the market converges rapidly to a competitive equilibrium under the double auction institution.

- a small number of market participants;
- not price-taking behavior;

The double auction turns out be an extremely competitive institution, given the temptation for traders to improve their offers over time in order to make trades at the margin.
Now we consider markets with posted prices (Bertrand or posted-offer) where sellers pre-commit to fixed, take-it-or-leave-it prices that cannot be adjusted during a trading period.

Specifically, at the beginning of a period sellers simultaneously commit to a price offer and fix the maximal quantity they are willing to sell at the offered price.

The set of prices chosen by sellers is revealed to all market participants.

Then buyers are randomly and sequentially selected. They can choose among the (still) available price offers and can buy as many units as they want.

Notice that sellers receive only very limited information about the buyers’ willingness to pay compared to the double auction.
Double Auction

![Graph showing Double Auction Transactions Prices for Treatment 1 and Treatment 2 with quantity on the x-axis and prices on the y-axis.](image-url)
Posted-offer Market

![Graph showing posted-offer transactions and prices for two treatments.](image-url)
Summary of the comparison between double auction and posted offer

- The results shown in the previous figures are fairly typical in replications in the literature.
- Compared with double auctions, laboratory posted-offer markets converge to competitive predictions more slowly and less completely.
- In the posted-offer markets, the efficiencies are initially very low.